Applications of Synchrotron Infrared Microspectroscopy to the Study of Fingerprints

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Designing effective strategies for advanced fingerprinting technologies requires an accurate characterization and fundamental understanding of the nature and molecular form of the organic molecules in the print and their chemistry. The surface/bulk chemistry of a fingerprint can be highly variable at the microscopic level, which arises from a small-scale (ranging from a micron to hundreds of microns) surface heterogeneity involving the distribution and mixing of organic molecules that come into contact with one another. One methodology commonly used to study this type of complex chemical system is that of combined microscopic imaging and spectroscopic techniques.

A number of organic molecules, almost all biologically based, have been identified as being present in human skin secretions that form fingerprints. These molecules are part of a mixture of complex chemicals, and they are part of a system, along with metal ions, that make up fingerprints on surfaces. In this study, modern synchrotron radiation-based---as well as conventional---infrared spectroscopic techniques have used to provide a better chemical understanding of the composition of human fingerprints with respect to their organic constituents. Results from the work here are important for the comprehensive characterization of chemical signatures of human fingerprints that will complement the traditional concept of fingerprints. The hypothesis of the proposed research is that the organic chemistry profile of an individual's fingerprint process is unique to that individual and that the assemblage of organic molecules present in the print can be monitored and studied using extremely sensitive analytical and spectroscopic techniques. Figures 1 and 2 show the distinct differences in the infrared vibrational spectra of fingerprints taken from two different people, one an adolescent male and the other a grown male.

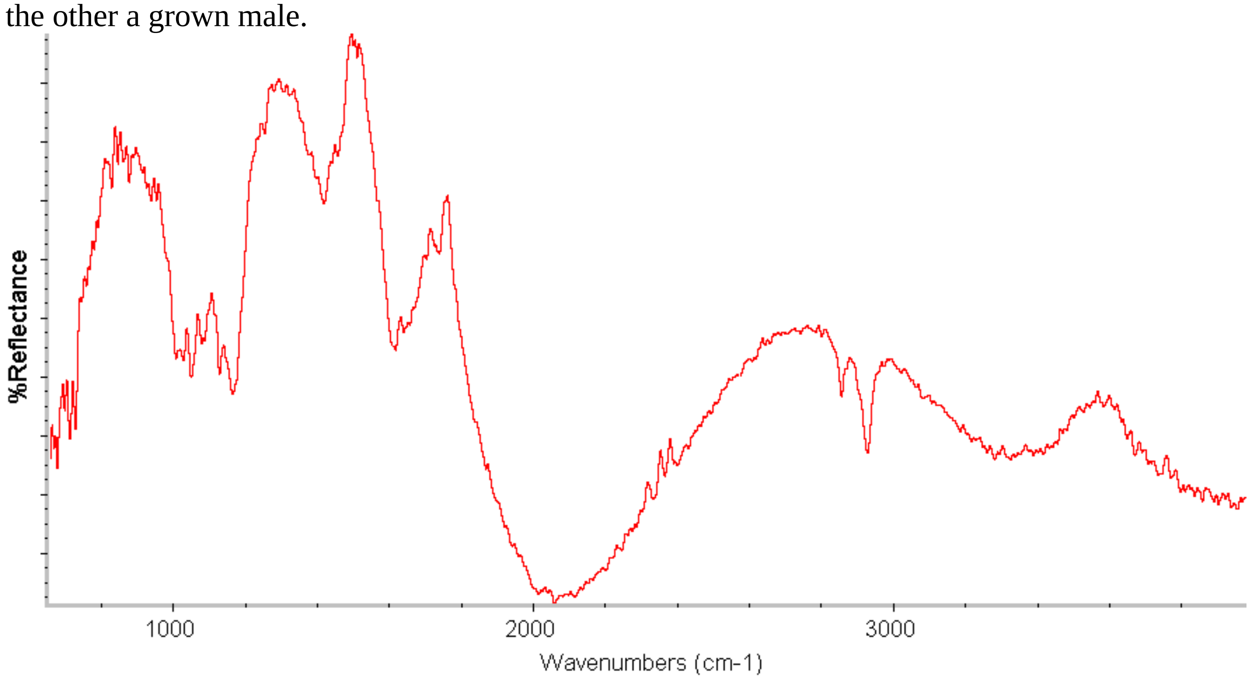

Figure 1. The infrared spectrum of an adolescent male.

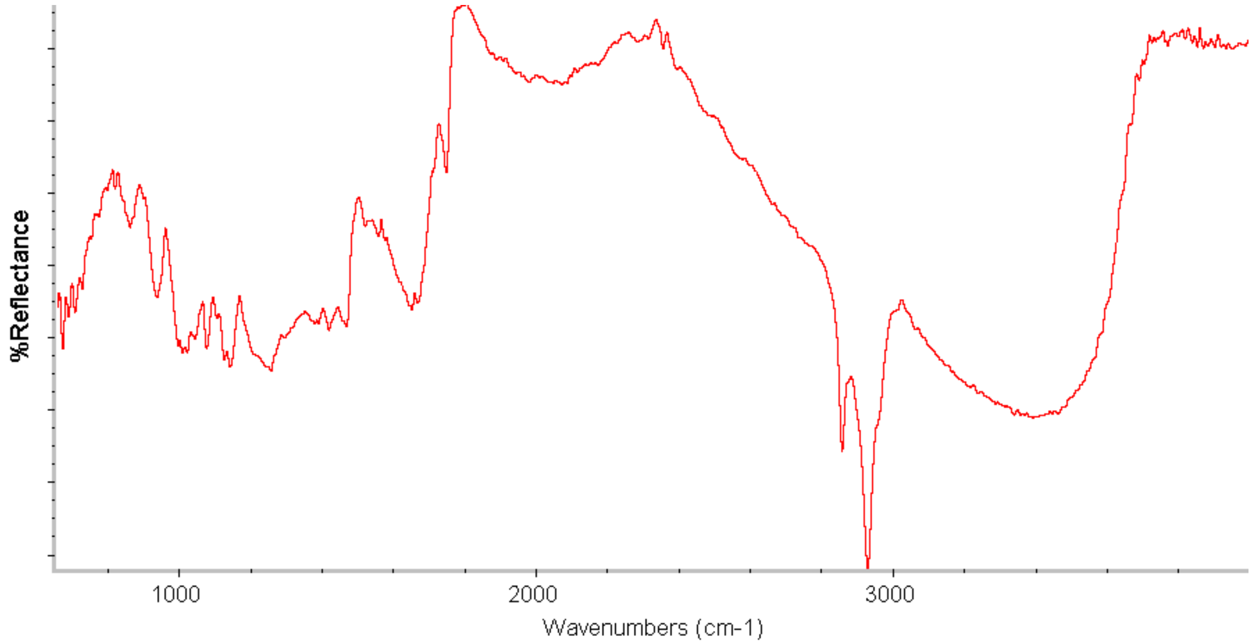

Figure 2. The infrared spectrum of an adult male.

The work here focuses on producing fundamental data relating to the identification of latent fingerprints through infrared analysis. The chemical makeup of sweat and related secretions are extensively documented in medical and biological literature. There are numerous techniques for the chemical and/or physical development of latent prints. To date, however, there has not been a systematic study of fingerprint sweat chemistry and the changes that it undergoes over time.

Using techniques already developed to observe the chemistry of the organic components of biologically based organic molecules, such as those found in microorganisms [H.Y.-N Holman, D.L. Perry, M.C. Martin, and W.R. McKinney, *Proceed. Mater Res Soc.*, **524**, 17(1998)] preliminary research has been conducted at the Advanced Light Source at Lawrence Berkeley National Laboratory. Initial data using the infrared beamline shows that different fingerprints can be clearly distinguished. Different organic molecules that are known to be in human fingerprints have been seen in the infrared spectra. In the initial research, SR-FTIR was chosen because of its proven sensitivity in providing direct molecular information on chemical compositions that involve complex organic molecular assemblages.

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